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ABSTRACT

Research on everyday learning has begun to illuminate some of the relations between activity and knowledge, and thus can help educators reconceptualize classroom activities. For example, how and what children learn about money epitomize many of the differences between everyday and school-based problem solving. The general goals of this paper are to characterize the problem-solving strategies used by children in stores and to show that the knowledge children have is a consequence of the ways in which they use that knowledge. Specific goals are to: (1) describe the situated use of money in both natural settings and the classroom; (2) describe the development of children's knowledge of money between preschool and the end of second grade; (3) relate children's knowledge of money to the ways in which they use money; and (4) describe some ways in which children reconcile what they know about money as it is used in and out of school. Discussion is based on observations of children's behavior in stores and classrooms, and interviews with parents and children. Implications for educational practice are briefly discussed. (RH)

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Everyday Problem Solving: Dollar Wise, Penny Foolish

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INTRODUCTION

The study of everyday problem solving and cognition is becoming increasingly important in efforts to improve and reconceptualize mathematics and science education. This increased interest in everyday thinking arises from a number of concerns. Children are being recognized as active constructors of their own knowledge rather than passive recipients of adult knowledge. As such, what learners know in one everyday context has an impact on what they know in other contexts, such as the classroom. Educators need to be aware of the knowledge and misconceptions that children bring with them to the classroom.

At the same time the goals of science and mathematics education are being transformed so that we now want our students to become practitioners of mathematical and scientific reasoning, novice members of an intellectual community (Brown, Collins and Duguid 1989; Hawkins and Pea 1987; Schoenfeld 1985). Problem solving and active laboratory inquiry are manifestations of these new pedagogical goals. As these goals become enacted in classrooms, students will be learning in physical and social contexts quite different from the traditional model of an individual learner wrestling with the symbolic world of the textbook. School learning will become more like everyday learning, where knowledge is situated within activities. Research on everyday learning has begun to illuminate some of the relations between activity and knowledge, and thereby can help us in the reconceptualization of classroom activities.

The example I want to deal with in this paper is that of money. While simpler and perhaps more structured than many other topics taught in science and math classes, how and what children learn about money epitomizes many of the differences between everyday and school based problem solving. The first goal of this paper is to describe the situated use of money in both natural settings and the classroom. The second goal is to describe children's knowledge of money as it develops between preschool and the end of second grade. The third goal is to relate children's knowledge of money to the ways in which they use money. The last goal is to describe some of the ways that children reconcile what they know about money as it is used in and out of school.

At a more general level, the goals of this paper are to characterize the problem solving strategies used by children in one natural setting (stores) and to show that the knowledge children have is a consequence of the ways in which they use that knowledge. The implications for educational practice are briefly discussed.

Everyday Knowledge Compared to School Knowledge

People become competent in many facets of their everyday lives independently of school experiences. In other cultures, people become adept mental calculators without the of benefit schooling or direct instruction in mathematics (Lave 1977; Petitto 1982). Within our own culture adults are competent and nearly errorless mathematicians while grocery shopping (Lave, Murtaugh & de la Rocha 1984; Lave 1988) and while doing routine computational tasks on the job (Scribner 1984). Yet in mathematics classrooms children seem to lose commonsense as they move through the school curriculum (Carpenter et al. 1980; Ginsburg 1977; Schoenfeld ip). The same adults and children that do so well in the supermarket and marketplace fail miserably when confronted with what seem like the same math problems on a paper and pencil test.

Children and young adults are also active theorists (at some level) when thinking about the phenomena addressed in science classes. For instance, nonscientists are able to create mental models of diverse situations such as electricity (Gentner and Gentner 1983), thermostats (Kempton 1987) and evaporation (Collins and Gentner 1987) which enable them to make productive predictions about how these systems work in a variety of circumstances. And yet, as in mathematics classrooms, everyday ideas about scientific phenomena fall short of standard educational objectives. Everyday knowledge is often fragmented and internally inconsistent (di Sessa ip, 1983) but resilient to the point of inhibiting learning of formal scientific knowledge. Children also have trouble extending their school learned scientific principles to their everyday lives (Linn and Songer 1988). As in mathematics, there seems to be a large gulf between everyday and school based thinking.

Situated Practice versus School Practice

Studies of problem solving in natural contexts repeatedly find that people use a multiplicity of problem solving strategies that are specific to the situation in which they are used. Scribner (1984) notes

that what appear to be routine and repetitive problem solving tasks for workers in a dairy factory in fact hid a diversity of operations hidden in same-problem formats. Seemingly small differences in the way dairy products are organized--milk comes in cases of 9 half gallons while cream comes in cases of 32 pints -- gave rise to different solution processes. In Lave, Murtaugh and de la Rocha's (1984) research on grocery shopping, shoppers used features of the supermarket environment to help them resolve 'snags', i.e. nonroutine decisions about which product to buy. These researchers assert that the environment shapes the way problems are construed by the shopper through means of how information is displayed, by helping to organize sequences of activity and by providing material support as a sort of calculating devices.

However, the situation-specific nature of everyday problem solving does not imply that the physical features of settings mandate a concrete, nongenerative set of problem solving skills. The "cultural practices" theory detailed by Cole and his colleagues (Laboratory of Comparative Human Cognition l983; Scribner and Cole l981) asserts that settings don't dictate the activities that occur within in them but that people construct the meaning of those settings through the practices that occur within those settings. Following Vygotsky's (l978) notions of socially mediated learning, the cultural practices theory implies that children and other novices learn skills and a way of interpreting their experiences in settings through their interactions with others in those settings. Saxe (ip) used a cultural practices approach when he studied the math skills used by young candy sellers in Brazil. He writes "Thus, the candy selling practice is a social context in which problems are configured as a result of the structure of the practice itself, a structure that is supported by a variety of social processes" (p. 7).

Lave, Murtaugh and de la Rocha's (1984) work on grocery shopping also revealed that problems in everyday life tended to have a routine nature which obviate the need for complex problem solving skills. Most decisions about buying products were based on criteria set outside of the store, such as how much of an ingredient is needed for dinner or what size box of cereal will fit in the cupboard. In a fraction of the shopping decisions, there is a 'snag' in which the choice of product is not clear. Through a variety of 'gap-closing' techniques the adult shopper comes to make a decision about which product to buy. Even when there is a desire to make a 'best buy', i.e. a purchase which is most economical, the school-taught tools of

problem solving such as arithmetical computation were only sporadically used. And the paper-and-pencil algorithms taught in school were never used. Adult shoppers used a combination of mental calculation, approximation, and features of the physical environment to help them make a decision, i.e. to resolve the problem of what to buy.

As characterized in the studies summarized above, everyday situated learning and problem solving differ significantly from school learning and problem solving. Resnick (1988) makes the following contrasts: 1) School emphasizes individual cognition while in other settings people learn with and through other people. 2) While school emphasizes mental effort, there is extensive tool use outside of school. 3)School subjects tend to emphasize symbol manipulation while contextualized reasoning uses features of the environment. 4) There is generalized learning in school versus situation-specific competencies outside of school.

These differences between situated and school learning have implications for educational practice. Pea (1987) argues that one of the main issues in contemporary education is that of transferring knowledge between different settings. What we teach in school is intended for use in work and everyday life, but too often the schools are characterized as failing in this endeavor. There is also suggestive evidence that students have competencies from everyday life which could enhance school learning. Greater understanding of situated practice and its impact on knowledge development will hopefully lead to new educational practices.

Money and Situated Learning

Money is a particularly apt domain for comparing everyday and school knowledge because children develop their ideas in the two settings at roughly the same time and through observable experiences. Children initially learn about money shortly before they start school through a limited number of activities, primarily spending activities and parental instruction. They also learn about money in school beginning in kindergarten, and money problems are common throughout the elementary math curriculum. However, as will be shown, the structure of money knowledge embedded in the two situations differs significantly while the vocabulary used to talk about this knowledge remains deceptively the same. The structure of everyday knowledge is formed by the activities that children do with money (spending,

saving) while the structure of school based knowledge derives from a "learning hierarchy" (Gagne 1970) view of the internal structure of money knowledge. Similarly, the ways in which problems are defined and solved differ significantly between everyday and school settings. The means by which children try to reconcile the differences between their school and everyday knowledge of the money domain may presage the difficulties children have with other domains of formal knowledge.

The data presented in this study support the contention that situated problem solving is a particularly powerful learning process. The knowledge that children develop while engaged in everyday activities gives shape to and may at times predominate over school based knowledge.

METHODS

Since the goal of this study was to look at the relationship of knowledge to practice, it was necessary to use a variety of research methods. The descripton of practice is derived from observations in stores, observations in classrooms, interviews with parents and interviews with children. The work was conducted in Honolulu, Hawaii and some of the surrounding towns.

Store Observations

In Honolulu there are three types of businesses which cater to children shoppers, although they are not oriented exclusively to children. In urban neighborhoods and in smaller towns, there are small family type stores which are often located near schools. These stores sell candy, snacks, comic books, small toys, and school supplies in addition to the typical sundries and groceries. There are "crackseed" stores which specialize in Asian snack foods such as nuts, pickled fruit seeds and preserved fruit as well as sodas and popsicles. There are also "manapua" trucks, somewhat akin to ice cream trucks, which sell hot food as well as candy, soda and cookies. The manapua trucks serve clients at construction sites, beaches and shopping centers but some make a special effort to find youthful customers. It is common to see a manapua truck parked outside the school grounds at the end of the school day or in parks where there are summer youth programs.

After an initial survey, 5 businesses were chosen for extended observation. These 5 sites included two stores in a low income neighborhood of Honolulu, 2 manapua trucks in a park in a town about 25 miles outside of Honolulu and 1 store in that same town. With the business owners' permission, I

observed children as they shopped at each business. I made written notes on the uses of money--the prices of items bought by children, what kinds of money they carried with them and what denominations they used in their purchases. I also looked for evidence of decision making processes--any calculations, routine practices, etc. I also made note of the social environment of each purchase--who accompanied each child, what kinds of interactions they had, how the storekeepers helped the children. I also audiotaped some days in order to have a more verbatim record of verbal interactions. Observations were made about twice a week over a period of six months.

Children and Parents

The children who participated in this study were all children at the laboratory school of the Kamehameha Schools. Most of the children were part-Hawaiian. The preschool children were drawn from the neighborhood around the school, the same low income neighborhood where store observations were made. Interviews were begun with these families in the summer before the school year began when the children were 3 1/2 to four years old. Parents were primarily interviewed in the first interview, although their children were present. Six focus families were visited at home weekly over the course of the school year and separate child and parent interviews conducted. All of the families were interviewed again at the end of the school year.

The elementary age children were drawn from all over the island, including the town where the manapua trucks were observed. The same group of children was followed from the beginning of kindergarten through the end of second grade. Interviews about money were conducted at the beginning of kindergarten, the end of kindergarten and the end of second grade. Information was also collected from standardized tests and classroom written work. Although the children in this class were chosen to represent an educationally-at-risk population on a number of dimensions (including ethnicity, socio-economic status, and verbal skills), they scored above national norms on standardized tests in math in all three school years covered by this study.

Interviews

In all interviews, money was just one topic among many (see Levin and Brenner 1986; Brenner 1989). Only the parts relevant to money knowledge will be described here.

The preschool interviews with parents were open-ended interviews about the literacy, numeracy and school-readiness skills that they wanted their children to have and which they had actually taught or observed in their children. Parents were asked about children's spending habits, when each child had begun to use money, what the parents had tried to teach about money and what they thought their children knew. It was possible to test only a few of the children's money knowledge during the first interview. Most of the direct information about children's competency with money is based upon the home interviews with the six focus families.

The kindergarten and second grade interviews had a number of questions in common. Children were asked to identify coins and a dollar bill and to tell how many cents each one is worth. They were also asked to describe what one needs to know in order to go shopping. This was done by asking the children what they would teach a novice shopper, a toy monkey in the case of the kindergarten children and a hypothetical younger sibling in the case of the second graders. The children were also asked where they normally obtained money and what they do with it. This information was further substantiated by written survey that was filled out by the parents of the children.

In addition the kindergarten children were asked to count some coins and to go through the simulated purchase of some stickers priced at 3 cents, five cents and ten cents. The second grade children were asked more details about money, such as how many quarters there are in a dollar. They were also shown pictures of common situations in which money is used including the check out stand at a supermarket, a produce stand and a gas station. They were asked to describe the picture and then to explain what any numerals in the pictures mean. (More details of this study are reported in Brenner 1989).

Classroom Observations

The children were videotaped doing their seatwork in math class through much of kindergarten and first grade. Teacher led lessons were observed in all three grades. In the second grade classroom, the researcher helped the teacher to implement a number of lessons on money. Materials from money lessons were collected including workbooks pages and mimeographed handouts. According to the teachers the formal curriculum in money is that laid out in the textbooks, so the textbook presentations are utilized in this study as the template for school-based knowledge about money.

RESULTS and ANALYSIS

There are three analytically distinct kinds of things that children learn about money--'facts' about currency, the scripts about how to use money in different contexts (Schank and Abelson 1977) and values about money. In practice, of course, all three types of knowledge are important in the context of using money. However, in the classroom, there is emphasis primarily on 'facts' about currency and money as a tool in the pursuit of mathematical goals.

Money in School

In school, knowledge about money is taught cumulatively over the first three years of elementary school. In kindergarten, children are introduced to pennies, nickels and dimes. They are expected to learn the names of these items as well as their numerical values. Pennies, nickels and dimes map very well onto the other mathematical skills taught in kindergarten. Much of the school year is spent on developing children's competency with numbers from 1 to 12--counting collections of objects, reading numerals and writing numerals. These same activities are done with money. In some textbooks pennies are frequently used as an example of an object to be counted. A unit on money often follows shortly after children have covered all the numbers up to 12. A major lesson about money which begins in kindergarten is skill at recognizing textbook representations of money. In the class observed, the teacher began her lessons about money by using play money that was a good simulation of real money. This play money had accurate pictures, realistic size and thickness and close approximations to the color of real money. The children practiced identifying and counting this play money before doing textbook exercises about money.

First grade extends the knowledge about money up to the fifty cent piece. As in kindergarten, an extensive amount of time is spent on practicing their identification skills of textbook representations of money, but the exercises are more elaborate. Workbook exercises include coloring different denominations of coins different colors, matching coins and numbers and using money stamps and ink pads to create collections of coins. Money is also used as a model for simple addition. In addition to putting together groups of pennies, teachers can use money as a model of the "counting on" method of addition. In this model of addition, the nickel is used to represent a group of five pennies. The children

are then instructed to add pennies to the nickel by counting up from the 5 cents represented by the nickel. Children also practice counting by fives and tens in the context of money activities. The most common workbook activities with money are adding up groups of coins. Most frequently the children are given a set of coins and asked to write the numeral which represents the total. The sums in these cases are any numeral up to about 50. The coins themselves have no particular organization. Less frequently the children are given a total, usually as the price for a toy or other object, and asked to mark the coins which add up to that amount. Money is also used as an example in various problem solving activities. For instance, in one workbook activity, the children are shown a picture of a produce stand. Each item of produce is marked with a price between 1 and 12 cents. The children are given addition problems through the device of being asked to add the prices of various objects such as a piece of corn and an apple.

By the end of second grade, the children have had extensive experience adding groups of coins to 100 cents. Unlike the earlier grade level textbooks, the second grade text (from another publisher) introduces the coin problems as an application of counting by 2s, 5s and 10s. On a couple of pages the pennies are grouped by fives to facilitate the counting approach to the problem. Most of the problems involve at least three kinds of coins although the children are never asked to add quarters. As before, the sums of coins can be any number and tend to include pennies. There is one page on the various combinations of coins that add up to a dollar and another on the combinations that add up to fifty cents as well as a page that introduces the combined dollar and cents notation. The class was also introduced to the idea of trading pennies, dimes and dollars as a model of the place value system. The idea was initially brought to the children's attention in a series of whimsical stories about a mythical kingdom in which the king and queen can change the rules about money as they see fit. Most of the children had workbook lessons using money as a model for two digit addition and subtraction. A few of the children progressed to the end of the textbook where money is used as a model for three digit addition and subtraction with regrouping. However, money was never the major model for place value and was just one model among many. As in first grade, money is also the context for other problem solving activities such as word problems. This second grade class also had a number of more active experiences with money. They

played a number of games such as money bingo in which children vie to be the first to cover all the squares on their game cards. The games tended to stress speed in recognizing coins and common combinations such as two nickels. There was also a classroom store in which children practiced selling items to each other.

In the middle of the school year, before the unit on money was taught, the second grade children took a written test on their money skills. Nearly half of the children had trouble recognizing the pictures of the coins, particularly the nickel and dime. The children also had difficulty adding up groups of coins (even when numbers were written on the coins) if the sum was beyond 25 cents or if the grouping consisted of dimes and pennies. Rather than trouble with money per se, the children displayed trouble with the school skills associated with money--recognizing representations and adding up groups of coins.

Figure 1 presents a model of how children are expected to learn money in school. They begin with pennies as individual items for practicing counting. Coins are introduced over the school years in the order of relative value. As shown in the balloons for each coin, money is presented as an additive system in which each coin can be conceptualized of as the sum of some combination of the less valuable coins. Although it is not shown in this model, there are relatively few representations of conventional coin combinations that equal the other coins. In other words, there is little emphasis placed on the fact that two nickels equal a dime. Rather, children are confronted with groups of coins that conceivably can equal any amount less than a dollar. The textbook tasks are much more like exercises in addition than lessons about money. The vast majority of exercises utilize coins in value from a penny to a quarter, while half dollars and dollars are introduced in passing. There is no statement of values embedded in this system. Each coin has equal salience as shown by the equal size of the type face and the relatively equal size of the balloons. Except for one or two pages at the end of second grade (which not all children reached), the cent symbol (¢) is used to denote that the numbers refer to money.

This model of money corresponds to Gagne's (1970) learning hierarchy in that competency with smaller coins is seen as a prerequisite to introducing larger coins. Dollars in turn are only introduced after students have had extensive practice with many combinations of coins that add up to sums of 99 cents. This is a fairly complex model because each coin (except a penny) is conceptualized as several

combinations of other coins. For instance, as shown in the figure, a quarter can be considered as equivalent to multiple combinations of other coins. The teachers tended to believe that the students developed the conventional groupings of coins such as 10 dimes equal a dollar, those represented in the darker balloons. The students were as likely to see the combinations shown in the smaller balloons. In fact, the textbooks did nothing to foster these images since coin combinations rarely summed up to the equivalent of other coins.

Money in Action

Shopping can be conceived of as a problem solving activity, although as Lave and her colleagues have shown for adult shoppers, 'problems' are not a major feature of shopping activities. For children the task of shopping is, in fact, potentially more problematic. Children are working in a situation of less information--they don't necessarily have a full map of the monetary system, nor can they read prices in the store reliably. They are in the process of developing and coordinating the three kinds of knowledge noted above--facts about currency, buying scripts and implementation of values about money. The question becomes, how do children accomplish buying goals in the face of their novice standing as a shopper?

Preschool

Most children are given small coins to play with by the age of four. The coins are often accompanied by a bank of some sort through which parents seek to instill an early sense of the value of saving. However, the initial impetus to buy seems to arise from children's desires to participate in the activities of those around them. M.H. began her shopping career at the age of three when she went out to the manapua truck with some other children. She came home crying when the manapua man wouldn't give her any ice cream in exchange for some Monopoly money and two pennies. Her parents bought her a money puzzle and began to teach her the value of different coins after this incident. By the age of four a few children are already buying things on their own at a store near their house or at a manapua truck. During the course of home interviews, the interviewer went shopping with the a few of these children (at the child's insistence!) and noted these children's clear familiarity with the routines of shopping.

More commonly, preschool children particpate in family shopping expeditions and do their first buying activities as part of the larger family activity. One mother described a typical shopping expedition:

Mother: Like if he wants something in the store he'll tell, "I want that, it's on sale, it's only 59 cents." He'll just make up his own price. I guess he hears us talking about sale things. He'll ask for a toy and say, "Mommy, it's on sale, it's only 59 cent," or "It's only dollar something."

The child in this example was unable to read prices or judge if there was enough money to pay for his toy. And if there was enough money, his mother would actually take care of paying for the toy--taking it to the cashier, giving enough currency to cover the price and receiving the correct change. As with the example of M.H., he has some of the pieces of the script and some of the main ideas about currency. Both he and M.H. know there are dollars and cents. In addition, the boy in this example also knows the value of a good price, as his statement "it's on sale" shows.

Preschool age children also enjoy shopping as a chance to participate in a routine family functions, not just as a chance for personal acquisition.

Interviewer: What does he tend to do with his money?
Mother: He holds onto it until he goes to the store.
Interview: Yeah. What kinds of things does he want to buy?
Mother: Sometimes he'll go there and he'll buy a toy and other times he'll go and buy him an Icee. But you know, he had $8.00 for his birthday and I didn't have any money. And I needed something at the store. Yeah, I needed to buy something to finish off my dinner. K. said, "I'll buy it." I told him, "You're sure?" He said, "Yeah, I'll buy it. My turn, my turn to buy for dinner." I told him, "Okay. You're going to treat for dinner today?" He said, "Yeah, my turn." So I buy it and he'll go home and he'll say, "Daddy, I bought dinner today."

Other children are an important influence on how children learn to spend money. Parents almost universally report that the first thing they want their children to learn about money is saving it. This soon comes into conflict with children's increasing desire to buy things with their money. One boy learned the 'true' meaning of saving his money in his piggy bank from his brother as follows:

Mother: He say, "How do you get the money back if you put the money down in there [in the piggy bank]? If I want to go to the store, how can I get it back?"
So my son [older brother] said, "You can not get it back. That's called banking it. Saving it 'til you come big."
"I can not use it?"
"Nope. Once you put it in there, that's it."
Then for a while he didn't want to put it in because he couldn't go to the store. So my boy [older brother] said, "No be dumb."
So he said, "Why?"
"Put 'em in. Daddy's. Daddy's. Use Daddy's money and save your money."
So now that's what he does.

In addition to teaching values about money, parents teach children the names of small coins and their quantitative value. For this purpose children are given small coins to play with and toys that reinforce these lesson such as puzzles, coloring books and toy cash registers. However, parents did not claim great success at teaching their children these things nor did they list money as an important area of learning in preparation for school.

The preschool child typically achieves shopping goals by becoming an apprentice to more experienced buyers--usually parents or older siblings. While most preschool children might have a hard time shopping on their own, they are quite adept at inserting their needs into the adult shopping script. Children are quite aware that money is necessary for shopping and that decisions must be made before reaching the cashier. Even by the age of four children show much initiative in the course of shopping. From parental accounts, those children who had become independent shoppers did so at their own initiative.

Shopping and Elementary School Students

Despite their relative state of naivete, children appear to be competent shoppers. They go about their business as shoppers quickly and efficiently. Even amongst the smallest of children it is rare to see a child who is unable to select and pay for all of his or her purchases. This competence is achieved through an interaction of the child's mastery of the buying script, the structuring of the shopping environment and judicious interaction with the social environment.

In most respects the script children use when shopping is like that of adults. They enter the business establishment, look at the mechandise, make a decision about what to buy, go to the cashier, pay for the item, receive change, pick up their purchase and leave the store. However, there are two major differences in the script used by children. One is that children are held accountable for having the right amount of money at an earlier stage in the script than adults are. When a child first approaches the cashier to pay for a purchase or to request something special (such as prepared food or items kept behind the counter) the child shows his/her money to the cashier. If the child fails to do this, the cashier will ask to see whatever money the child has. Only then is the purchase rung up on the cash register and prepared for

the customer. The second difference in the child's script is that children will do several loops through the script in the course of one shopping expedition. This will be explained more in the discussion below.

Only the smallest of children had trouble with the buying script. The most common type of statement about buying by the kindergarten children was "Remember, everything costs money, even candy." Another relatively problematic step in the script is remembering to take one's change. Small children would sometimes forget their change while shopping. Several of the shopkeepers would put the change in the bag in with the purchase for the very small children so as to avoid this problem.

Overwhelmingly for children, the largest problem in shopping is knowing how much you can get for your money. Not only do children lack complete knowledge of the money system, prices are often not clearly marked on the things that children buy. The second grade children said they would advise a younger child to make sure he or she has enough money when shopping. The following exchange with one boy exemplifies this point.

Interviewer: ...And what should he do when he wants to buy food?
K.: See, see how many money he has, and then ask for some more.

As with adult shoppers the experienced child shopper has a variety of strategies for dealing with this situation. Most frequently children have regular shopping routines which make the problem disappear. Thus many children buy basically the same thing day after day and use exact change to pay for it. As in Lave, Murtaugh and de la Rocha's (1984) study of adult grocery shoppers, there is usually no need for computational skills during the course of buying. Another strategy is to pay with a quantity of money that is guaranteed to be more than the cost of the purchases. As shown in Table 1, paper money is used alone in 28% of the purchases. The children using bills are most likely to be the youngest. Quarters are also used in this way. Another variation of this strategy is for children to have a handful of change which they place on the counter so that the storekeeper can pick out the correct amount.

On occasion it is necessary for a child buyer to use computation in the course of shopping. Sometimes a child has only small change and must put together a collection of coins in order to have enough money to pay. However this occurred in only 12% of the purchases. Furthermore, children almost never pay with more than two kinds of coins, they seldom use large collections of coins and

purchase only one item at a time in this situation. Thus this strategy is used in a very simplified manner which makes it amenable to the mental arithmetic available to elementary age children. Needless to say, children do not use pencil and paper or calculators when shopping.

A more frequent situation that calls for computation is when a child sets a goal of using up all his/her money in one shopping expedition or wishes to buy several items. The common solution to this problem is for the child to make several iterations through the buying script, or to do what I have called serial purchases. On the first time through the script the child will typically buy a relatively large item and then receive change. The child inspects the change and makes a smaller purchase. If change is received once again, the child will make another purchase. This is an instance of what Scribner (1984) would call substituting physical effort for mental effort or what Lave (1988) might term using the environment as a calculating device. A variation of this is when siblings go shopping. The oldest child will make a purchase and then pass the change along to the younger sibling.

The final strategy for managing computation is a division of labor among several participants. One child handles the shopping script while the others do the mental work of calculating amounts of money. One situation in which this strategy was seen was when several children were shopping together, but only one child had money. The other children offered various combinations of items such as "If you buy this one, you get only one. But if you buy this you can get two." Or "If you buy this, you get ten cents change." Often this was an attempt on the part of the other children to elicit sharing behavior from the child with money. This strategy was also one way that older children supervised the shopping of younger children.

If it is to be argued that children derive their knowledge of the money system from their shopping experiences, it is necessary to characterize the money system as seen in the course of this activity. Table 1 summarizes the relative proportions of the money usage observed in this study. Quarters and dollars were by far the most commonly used denominations. Bills or quarters were used in a total of 68% of the purchases. In contrast, the penny is almost never used. Although pennies were observed in 11 (5%) purchases, this exaggerates the relative importance of the penny. Four of these purchases were made by the same boy in a fifteen minute time span. He bought one item with 5 pennies and went home. He

returned a few minutes later with another 5 pennies and bought another item. He repeated this cycle two more times. Two other purchases involved 50 cent rolls of pennies and once again seem like an exceptional rather than typical case of money usage.

The price structure of items that children buy is also organized so as to highlight the importance of quarters and dollars and minimize the usage of other coins, particularly pennies. Although Hawaii has a 4% sales tax on all items, the things children buy have the tax incorporated into the price of the item so that all prices paid by children are in units of 5 cents or more. Consequently children never need to pay with pennies and they never receive pennies as change. These same establishments will charge adults tax on some of the same items for which children don't pay tax. Some stores also carry small varieties of candy that cost less than 5 cents per unit (what used to be called penny candy!). However, the storekeepers prefer to sell two items for 5 cents and avoid letting children pay with pennies.

Overall, the patterns children see and use in the course of buying suggest that money is a intrinsically a system in which a dollar (or sometimes quarter) is the canonical unit and the main process is one of breaking it into smaller units. Children see money broken into parts when they receive change after a purchase, and this is exploited in the serial purchase strategy. They often benefit from this process of breaking a larger unit into parts, as when a parent or older sibling passes the change along to the younger child. Children are also aware that there are machines which will turn a dollar bill into change. In contrast, children seldom see or use groups of coins in the course of buying. In particular they seldom see pennies at all.

Since no effort was made to interview children during the course of their shopping (it was judged to be too distracting), it is hard to say which values motivated children as they shopped. However, siblings often gave each other warnings and reminders. There were a number of instances in which children told each other "Don't spend all your money--save some" or "Don't buy junk food like candy", reflecting the values parents reported teaching to their children. From our observations it can be said that these commands were ignored, even by the children who made them.

Money Knowledge

The money knowledge of the preschool child is rudimentary but clearly defined from the child's point of view (Figure 2). Most of the preschool children were able to identify dollars and quarters. Although the children were clearly aware that more is better, they were evenly divided between those who preferred quarters and those who preferred dollars. Quarters were salient for many children because quarters had an aura of tangible worth and a direct correspondence to the prices of various things. One quarter is good for a video game while two quarters will buy a soda. Those children who preferred dollars were aware that one dollar could turn into several quarters and that in general more can be done with a dollar. As one mother put it, "He thinks the dollar bill is the best thing in the world. None of those little change things." Other silver coins were also considered to have some worth and hence in the realm of real money. But preschool children were unanimous in their disdain of pennies. One of the most frequent phrases heard during the interviews was "Pennies are junk!" The children knew that pennies were practically useless for making purchases and kept them separate from the real money. As one mother told us, "He has lots of banks but it's all filled with pennies, or coins. So he has this little coin purse that he stuffs all the silvers inside." If not kept in banks, pennies were often relegated to the toy box along with the play money. While money is essentially unquantified at this stage, there is a definite sense of more and less worth as shown by the vertical dimension in the figure.

The kindergarten child has a much more coherent sense of money as a sytem in which the various components have structured values relative to each other. (Figure 3) Ninety per cent of the children indicated that a dollar can buy more than any of the coins and that various combinations of coins can add up to a dollar. At the beginning of kindergarten a majority of children could name each of the coins except for the nickel. (Table 2) However, very few of the children could tell how many cents the coins were worth. None of them were able to say how many cents were equal to a dollar but several of them offered the observation that a dollar can be converted to 4 quarters. As for the preschool child, dollars and quarters have a special salience to the kindergartener (shown by the large typeface in the figure) since these denominations have a proven utility in the marketplace. Interestingly, although some children had trouble identifying the quarter when it was first shown to them, they spoke knowledgeably about the quarter when discussing things they liked to buy. Kindergarten children were also more aware than preschool children

that nickels and dimes could be useful. They made comments such as "A quarter and a nickel can buy a babypop" and "You can use all of these in the restaurant except the penny." There was little indication that the children believed that pennies could be converted to other coins, and this is indicated by the dotted line connecting pennies to the other coins.

In kindergarten the children began to use the vocabulary for money in a very particular way. While both dollars and coins were money, only coins could be spoken of as cents. In fact, it appears that for many children the word 'cent was synonymous with the word 'coin' and that this caused much confusion for the children. The question for asking the value of coins during the interviews was "How many cents is this?" The high percentage of correct answers to this question for pennies at the beginning of kindergarten is probably an artifact of this confusion. {Notably, this same confusion was found for 3 other classes of kindergarten children and is not just a fluke for this sample of children.} By the end of kindergarten the children seemed thoroughly confused and only 27% of the children were able to answer this question for the penny. Otherwise there were only modest increases in children's knowledge about money over the kindergarten year despite the direct instruction on pennies, nickels and dimes. This knowledge was also distributed among the children so that most children knew the value of at least one coin. Unlike many other lessons, the more academically oriented children were not more likely to have money knowledge.

Kindergarten children were only partially aware of standard notations for money. While most had no trouble reading small prices such as 3¢ and 5¢ at the beginning of kindergarten, none of them could read $5.75 at the end of the year. This latter number was typically read as either five dollars or five cents.

By the end of second grade, the children as a group have firm control of basic money knowledge (Figure 4). With only a couple of exceptions, every child knew the names and values of all coins. The dollar was more problematic. When the interviewing for this project began, it was found that of the first 5 children interviewed, only 1 could determine the number of cents in a dollar. And for this child it was derived knowledge:

Interviewer: Alright, how many cents is each one worth?
A.: ...That's dollar, worth 4 quarters. [pause] It's hundred pennies, or hundred cents.
Interview: How'd you figure that out? Did you remember, or did you figure it out?

A.: 10, 10 plus not 9, 10 times 10 is hundred.
Interviewer: Is that how you really figured it out?
A.: I, I usually do it that's why. I count. 'Cause I have lots of dimes at home, I count.

Unfortunately for the research project, the classroom teacher was very distressed that the children did not know the value of a dollar . Soon thereafter, the children had an extra lesson on money which included the dollar/cents relationship. Even so, a number of children had to figure out the value of a dollar from their coin knowledge. In the figure the varying meanings of a dollar are shown by the arrow directly connecting the pennies and dollar, as well as the mediated connection through the other coins.

Although it was not covered in class, the majority of children (80%) knew that 4 quarters equal a dollar. They were much less sure how many nickels equal a dollar. Quite a few of them made valiant efforts to count by fives but were stymied by the effort of keeping track of the number of fives counted. The second grade children continued to use the word "cents' as synonymous with coins as well as a synonymous for penny. When asked how many cents in a dollar, half of the children immediately answered "four quarters". For several, the question had to be rephrased as, "How many pennies are there in a dollar?". The distinction between dollars and cents was also made when children talked about what they would teach a younger child about money. It was commonly said "First I'll teach him about dollars and then I'll teach him about cents." The children also interpreted the conventional dollar and cents notation ($__ . __ __) as the conjunction of the two types of currency rather than as an indicator of cents being a fractional part of dollars.

For second grade children as for younger children, dollars remain the most salient unit in the money system. It was judged most important and the information that a younger child most needs to know. When talking about their own use of money, the children inevitably focussed on dollars. One child said, "Oh, my dad said he going gi' me allowance, um what's that called? He said, '25 cents a day.' I said, 'no, dollar.' He said, 'No then I not going give you nothing.'"

Second grade children only partially bought into the values about money taught by their parents. Most acknowledged the value of saving and had piggy banks or bank accounts but none of them had any clear goals for their personal savings. At the same time the word 'save' seemed to have a wide range of meanings for children. In addition to accumulating a large amount of money, it was used to mean that

some money was kept for use on another occasion. Thus some children said they had saved money because they still had 29 cents that they hadn't yet spent this week. As compared to the preschool children, money seemed to have an intrinsic value to the individual child and was seen as a personal possession. There were many complaints about money being "stolen" by parents or siblings, and little mention of any sharing. In this context saving was also problematic since saving a large sum of money left one vulnerable to having that same large sum of money being appropriated by someone else.

It was apparent in the second grade class that some children had more shopping experience than others. There was a small group of children, including some of the brightest in the class, who displayed a different set of knowledge pieces about money than the majority. These children were more likely to know that a dollar was equal to 100 cents than they were that a dollar equals 4 quarters. In addition, they felt it was more important to learn a penny first and build up knowledge of coins before learning about dollars. They reported that they had little spending money of their own and that someone else typically made purchases for them.

Comparison of School and Everyday Money Knowledge and Practice

A comparison of the four figures shows that what the school seeks to teach about money and what children know is quite different. Over the three school years covered in the study, the school curriculum gradually covers the components of the money system from the smallest unit up to the largest. In preschool, the children are most familiar with the two large units--dollars and quarters. In kindergarten, the children begin to develop a binary view of the money system. As shown in Table 2, the children are most likely to identify both pennies and dollars. In the school model, the penny is the building block of the money system. While kindergarten children don't see pennies as the most fundamental unit for money, they do include pennies in the realm of money, unlike preschool children. The kindergarten child also begins to develop a new meaning for the word cent. At the beginning of kindergarten, a cent means a coin. So the question "How many cents?" means how many coins. With this meaning of the word, it was easy for children at the beginning of kindergarten to say how many cents in a penny--one. They also said there was one cent in a nickel and one cent in a dime. However, this question was totally meaningless for

the dollar since a dollar is not a coin. By the end of kindergarten children had been exposed to the school meaning of the word cent--a unit that covers all coins.

By the end of second grade, the child's model of the money system is much more differentiated. However, the dollar remains the primary unit for children. Almost all of their discussions of money center around dollars and they seldom mention cents at all. Some of the children are coming to realize that there is a direct relationship between pennies and the dollar as in the school model. However, for many of the children this relationship is mediated by the other coins. Rather than being a grouping of lots of different kinds of coins (as in the school model), the dollar overwhelmingly represents a set of four quarters which in turn can be converted to groupings of other coins. The second grade child is much more conversant with the standard notation for money than is assumed by the school materials. Although the notation $_ . _ _ was never used in the textbook (except for one page that showed $1.00), virtually all of the children were able to read numbers such as $5.75 on a cash register and on a receipt. They were even able to read .75 as seventyfive cents in the context of a receipt.

As stated in the descriptions given earlier, children do quite different things with money in school and the real world. Consideration of the computational uses made of money in the two settings reveals numerous differences. The predominant school exercise with money is counting and adding up groups of coins. In real life children need to make relative judgements about money (which is more--the amount of money I have or the price of this object) and they need to decide how much money is left once part is spent, i.e. subtraction. Thus the child's model of money is an ordinally organized system and knowledge of the precise values of coins and bills develops later. At the early grade levels, there are many fewer denominations in the school presentation of money but these have very precise values attached to them. One of the early lessons children need to learn in school about money is that answers must reflect a certain level of precision. In a test at the beginning of kindergarten, the children were asked to indicate which coins one would use to pay for stickers costing 3¢, 5¢ and 10¢. The school based expectation was that the children would indicate coins that matched these exact values. In fact, many of the children indicated coins that more than covered the cost of the stickers, such as a quarter. In school this is a wrong answer, but in the store this is an acceptable answer; in fact more acceptable than using a bunch of

pennies as payment. The adding exercises with money also required a level of precision not seen in everyday life. The sums in these textbook exercise most often equalled values such as twentythree cents or fiftysix cents. In real life children almost never see prices that are differentiated by less than 5 cents. When asked to estimate prices of things when looking at pictures, the children almost always used prices like those seen in stores. In fact they often expressed prices in terms of coin denominations such as "two quarters" or "dollar something".

Neither the school model nor the model of money developed by the children untilizes the base ten system as an organizing element. Children do not easily think of a dollar as composed of ten dimes or 100 pennies. In school, children experience few problems where only dimes and pennies are used to make a sum. The counting-on procedures focus heavily on nickels and pennies. Higher sums of money are general obtained by using mixed groups of coins, often with three or more kinds of coins involved. In real life children don't use combinations of dimes and pennies when shopping; this was simply never seen. Most frequently quarters were used with other coins, so 25¢ serves as the anchor when figuring out the value of a set of coins. When loose pennies were used for shopping, the children always stacked them into groups of five. While the base ten system is latently visible in the standard notation for dollars and cents, the school did not exploit this to teach place value. The children were never given groups of coins to add up which exceeded 99 cents. Thus they never had the experience of converting cents to dollars and cents.

Money is clearly a value laden and emotionally charged subject for children. When considering a child's model of money, it is impossible to dissociate the values and emotions from the more quantitative content. For this reason, the figures of the children's models of money use different sizes of fonts and exclamation points to show the relative value of different denominations. It is quite conceivable that a child would assert that 56 pennies equals more cents than 2 quarters, but that 2 quarters are more money and are therefore more desirable to own. And they would be right when it's time to go shopping.

Children's Reconciliation of School and Everyday Money Knowledge

The differences between school and everyday money practices and knowledge do not escape the notice of the children. For most children the result is a separation of the two systems of knowledge.

The children come to understand that school money and real money each has a domain and that one reasons differently in the two. An example from the first grade math text exemplifies this phenomenon. The picture shows some children selling produce at a roadside stand. The prices for items such as corn, apples, oranges, cucumbers, cups of apple juice and watermelons range from one to twelve cents. None of the children had trouble recognizing that this was a picture about money. However, when questioned 89% of the children admitted that the prices in the picture were indeed unreasonable. In particular, the cup of apple juice for three cents caught the children's attention. Some of their reasoning about this is shown in the following quotes:

1)
Interviewer: And, do they seem like good prices or are they too high, or too low, or?
C.: It seems good.....This is a good price, for 3 cents.
Interviewer: 3 cents for the apple juice.
C.: No, no, no! Just the cups. One cup.
Interviewer: Oh yeah, this is for the cup. That would be...a normal price for a cup. What about a cup of juice? Would 3 cents be a good price for that?
C.: No-ho.
Interviewer: What would be a better price for that?
C.: Dollar, dollar something.

2)
Interviewer. So are you telling me that these prices are, are too cheap like say compared to our supermarket prices?
J.: No, too less. Cause um, apple juice should be about 5 cents or at least one dollar. But I know why they make it 3 cents, cause they only have little cups.
Interviewer: Oh, I see
J.: Like, about that big. [Indicates small size with his hands] Just try to taste it.

C. interprets that the cups alone are for sale, while J. assumes that the little cups are samples for people to taste. Another child noted that the people selling the things in the picture were children and therefore the prices were good so that other "children like me" could buy the things. The two examples also show how the children transform the picture prices into 'real' prices, by putting the price in dollars instead of cents. As another girl said, "almost all prices these days are dollar something". Another boy said, "If it [this price] came true, I would buy." On the face of it, it's not particularly harmful for children to learn the demands of the school setting as differentiated from other settings. But it causes some children to lose skills that they already had. At the end of kindergarten, one boy told me "I no longer know quarters because we don't do them in kindergarten." Other children lose confidence in their own commonsense because the school reality is so different from real life. C., who was quoted above as reinterpreting the

apple juice situation to mean that cups were for sale, is one of these children. She was very strong in her money skills but was less successful in school math.

Other children realize that school exercises are just that--exercises which have little intrinsic interest or meaning. Most of the textbook work on money is a dreary application of other skills such as adding or counting and has little to do with really learning about money. The children do what they must to get through these exercises, but see little that they really need to learn. In contrast, the classroom store in the second grade class motivated children to really learn about money. The store was only introduced after the children had spent weeks doing the textbook exercises. Then the store was instituted and a schedule drawn up so each child would have a turn as cashier. Suddenly before their turns as cashier, the children were requesting extra help on their money skills. Some of them painstakingly made themselves study cards with the value of each coin and the sums of some combinations of coins. During their turns as cashier, the children showed amazing skill at the task. They were able to add up the prices of the customer's goods, add up how much money was offered by the customer, find the difference of the two, and then make appropriate change. While mistakes were not uncommon by the cashiers, the children had much greater success on the job than while doing seemingly simpler worksheets.

CONCLUSIONS

The ways that children work with money in and out of school exemplify many of the differences between academic and everyday reasoning as summarized by Resnick (1988). Shopping is a social activity. At the beginning children learn to shop and use money as subsidiary companions on adult shopping expeditions. When they begin shopping on their own, the children nonetheless depend on others, particularly when there are nonroutine decisions to be made. When trying to maximize the amount of things to be bought with a limited amount of money, children allow others to carry the computational burden while they carry through with the general buying script. In the case of serial purchases, the cashier makes the computation while at other times a shopper's friends will help.

Shopping involves tool use of a sort as well. The cashier might use the cash register to make change; the child in turn uses this change to solve the problem of how much money is left for another purchace. The child will use money itself as a tool to avoid mental effort. It is certainly easier to use a dollar

bill for small purchases than to count up a bunch of change. A child's model of money develops as an ordered system so that it can be an effective tool in the course of shopping.

In school money is treated as a symbol system to be acted upon like the other symbol systems taught in school. Thus problems with money are usually addition problems with a numerical answer, much like other pencil and paper addition problems. There are few clues to the expected answer apart from the pictures of the coins. In the store, the entire environment is supportive of successful buying. The child's buying script incorporates a step of accountability (showing money to the cashier) which precludes many errors. The prices have a limited range of possible values and these are closely tied to the denominations of money that are acceptable in the store. As mentioned above, children receive help with computation through the social environment of the store. In addition, the items that children buy are often arranged by price as well as food category. Thus cheap candy is often on the counter while twentyfive and fiftycent candy is arranged in another display.

Certainly the money knowledge that children use while shopping is specific to that activity. As was shown, what children need to know in school is different than what children need to know to go shopping. However, it's not clear that what children learn about money in school is a more generalized skill that would be applicable outside of school. Although in early elementary school the children learn to do a lot of counting and computation with pennies, this is not a useful skill in the store. No storekeeper wants to serve a seven year old with a handful of pennies. In addition, children learn to limit the kind of reasoning they apply to school problems. With money problems they must learn to suspend reality and dismiss commonsense in the school setting. This supports various authors' contention (Brown, Collins and Duguid 1989; Lave 1988) that school is just another context which has its own set of conventions rather than being a 'decontextualized' situation.

This study of shopping also shows that people can look like adept problem solvers in the face of insufficient knowledge. If children had to take a school test on money as a qualification for shopping, they wouldn't be allowed to shop in most stores until third grade. However, children are competent shoppers because they have general knowledge about the structure of the money system, they know what their

goal is for the activity, they have a general script for pursuing the goal and they know how to use their environment for taking care of those parts of the problem which are too difficult to do alone.

This characterization of effective shopping is typical of situated cognition in many domains (Brown, Collins and Duguid 1989). Powerful learning can occur when students engage in meaninful, situated problem solving activities. The classroom store embodied an amalgamation of school goals and everyday experience that motivated children in a way that normal classroom activities did not. The children were able to use their knowledge of the buying script, the power of dollars and their school based computational skills in one activity that combined the best attributes of everyday wisdom and school precision.

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Table 1

Money Used by Children During Purchases
(N=184 purchases)

Denomination	Used Alone[1]	Used with with others[2]	Total Percentage of purchases made using coin/bill[3]
Large bills	5%	0	5%
$1 bill	23%	2%	25%
Quarter	28%	10%	38%
Dime	10%	4%	14%
Nickel	13%	5%	18%
Penny	4%	2%	6%
Food stamps	5%	1%	1%
TOTAL	88%	(24%)	(117%)

Notes:

[1] This includes cases where only one coin/bill is used and cases where the buyer uses several coins of the same value. In cases where the buyer used 2 or more coins of the same value, it is counted as only one instance.

[2] Each purchase in this category is counted at least twice, once for each different coin/bill used. Thus the column totals 24% but represents only 12% of the buying events.

[3] This column totals more than 100% because in some purchases more than one kind of bill/coin was used

Table 2

Money Skills in Kindergarten

	Beginning of School (27)	Second Semester (26)
Identify Money		
Dollar	93%	96%
Quarter	56%	65%
Dime	56%	58%
Nickel	41%	50%
Penny	74%	81%
Specify Amount		
Dollar	0	0
Quarter	11%	12%
Dime	19%	27%
Nickel	7%	23%
Penny	63%	27%

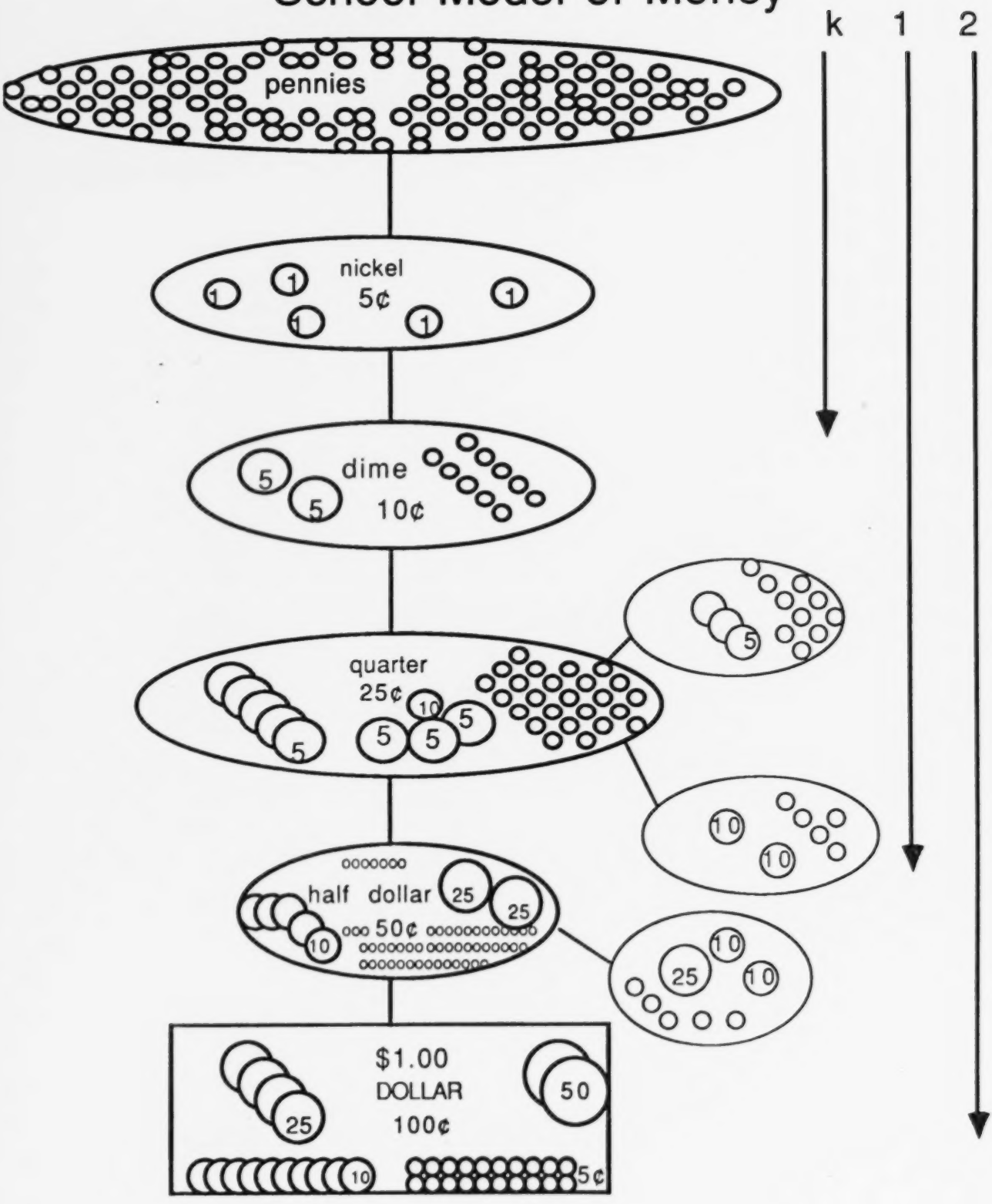
School Model of Money
k
1
2
pennies
nickel
5¢
dime
10¢
quarter
25¢
half dollar
50¢
$1.00
DOLLAR
100¢

Figure 1

Preschool Model of Money

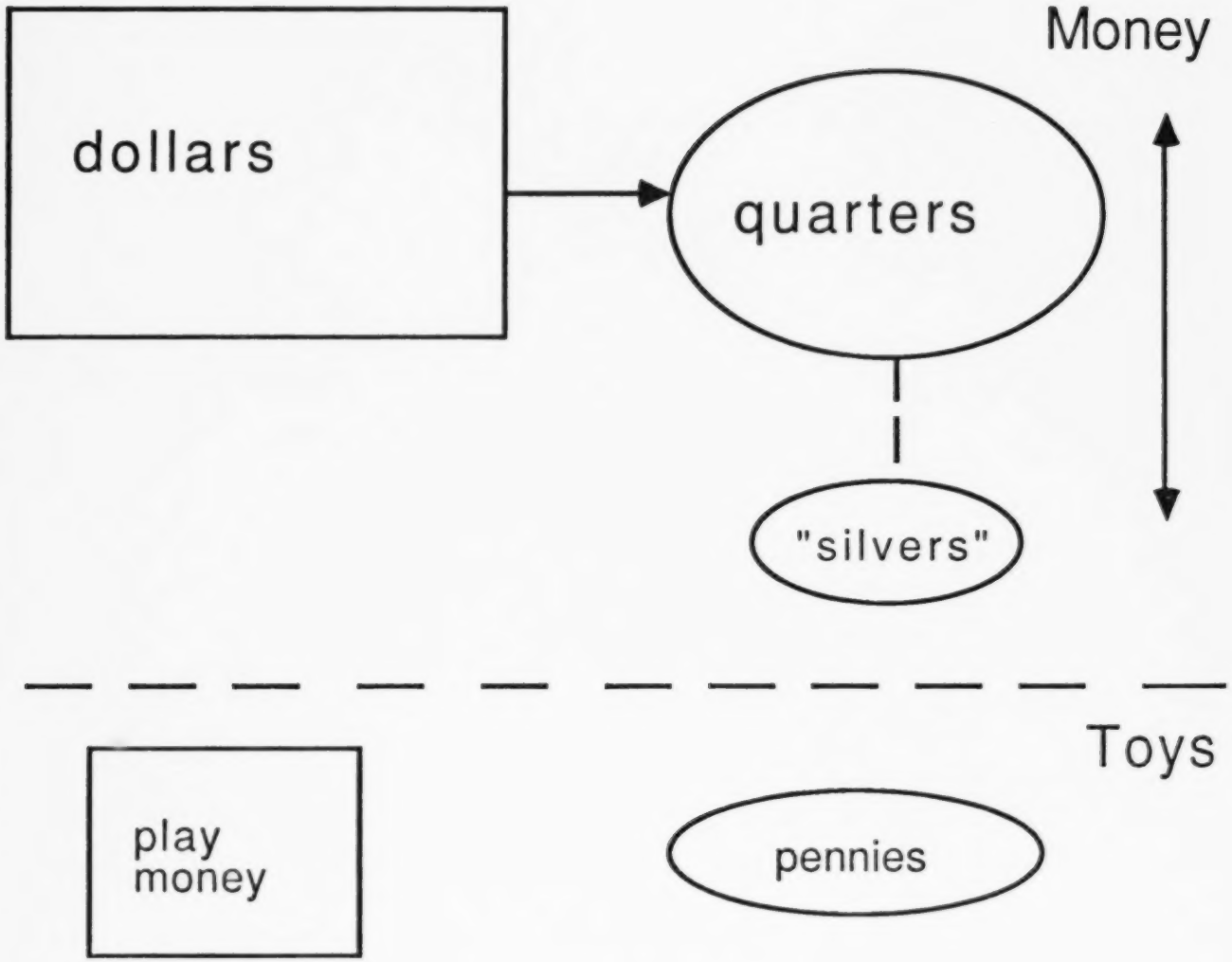

Figure 2

Kindergarten Model of Money

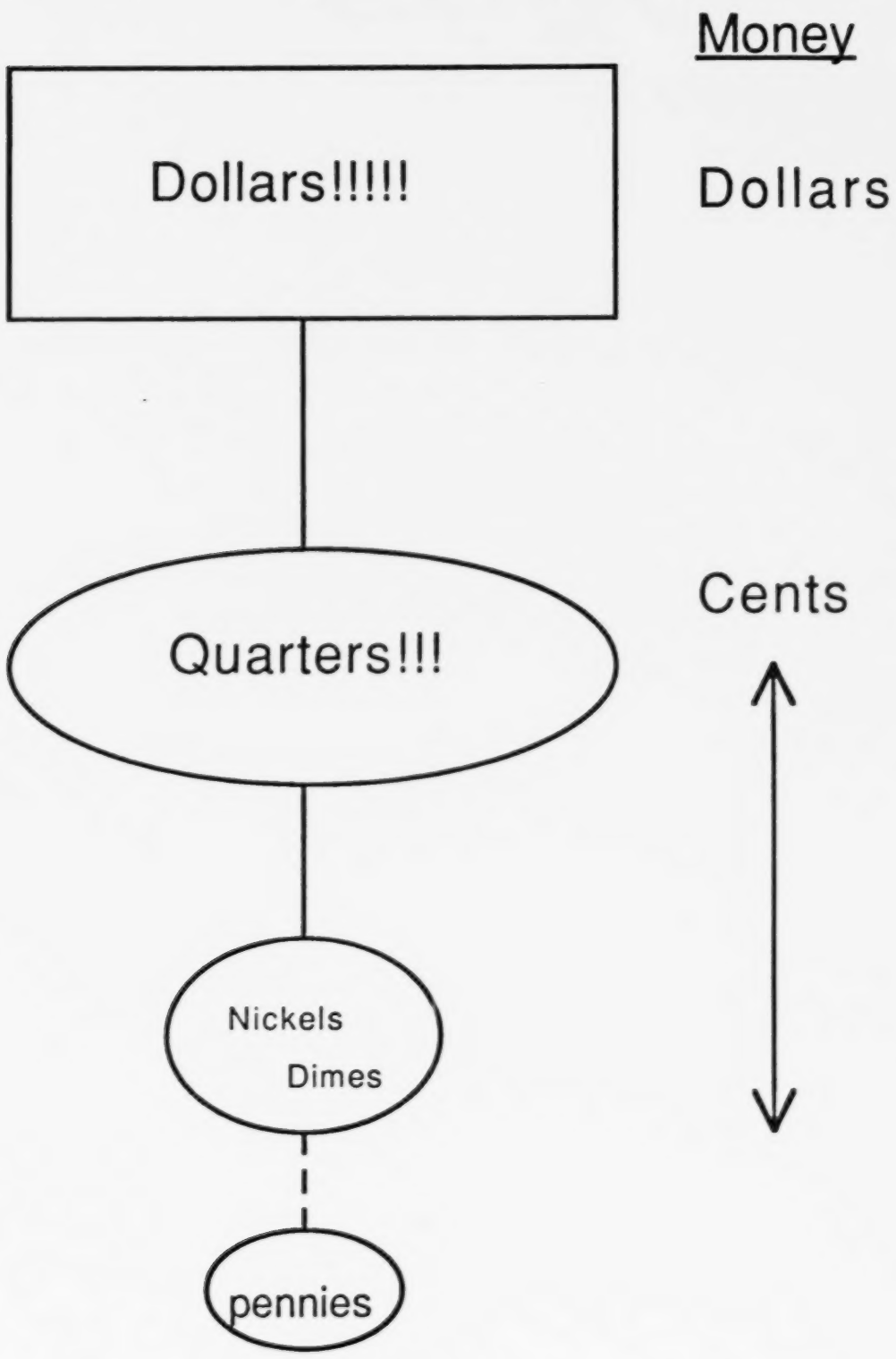

Figure 3

Second Grade Model of Money

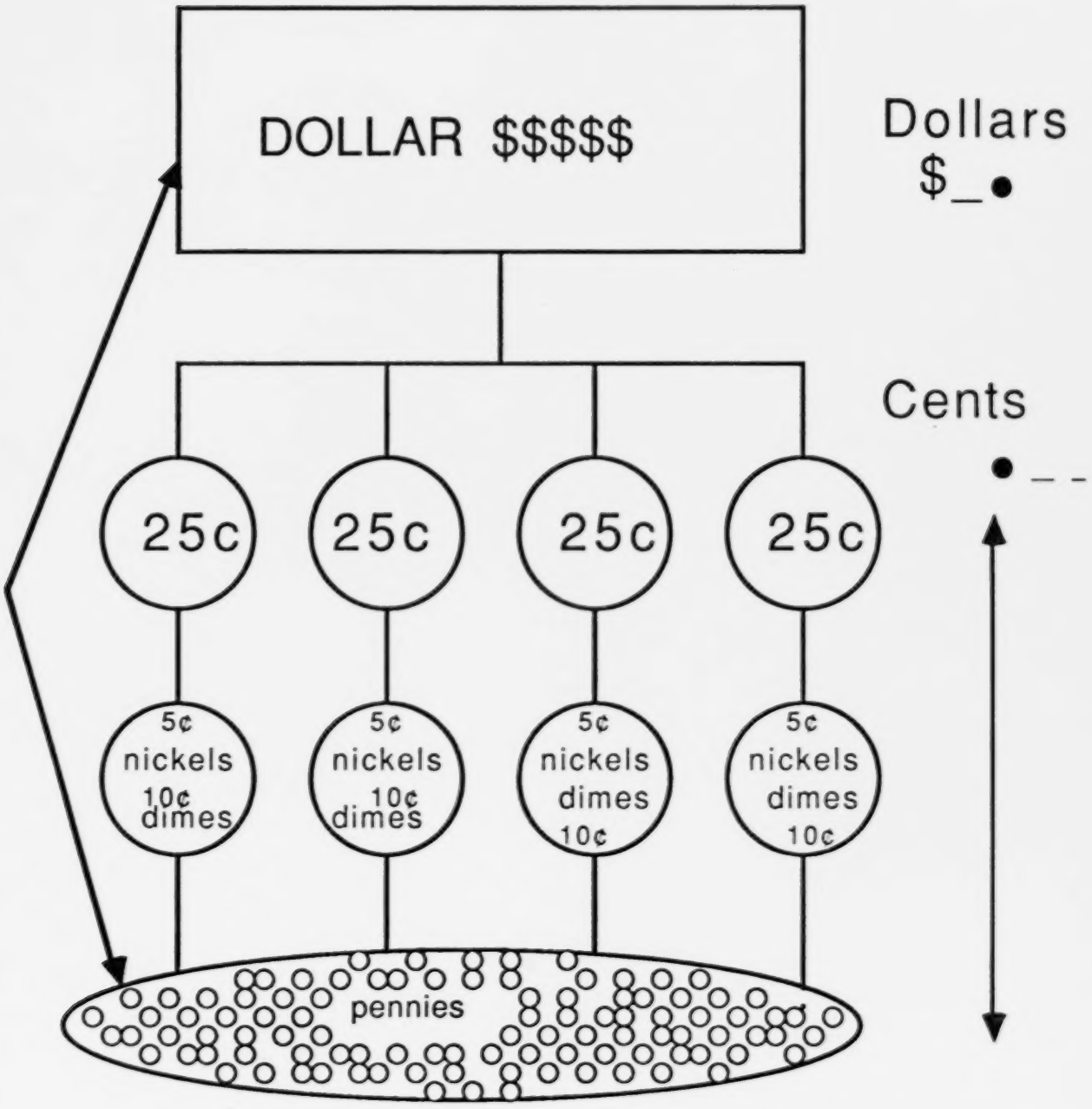

Figure 4